Aug. 2, 1938. D. P. KEARNEY 2,125,379

AUTOMATIC STARTING MECHANISM

Filed Nov. 30, 1931 2 Sheets-Sheet 1

Fig. 1

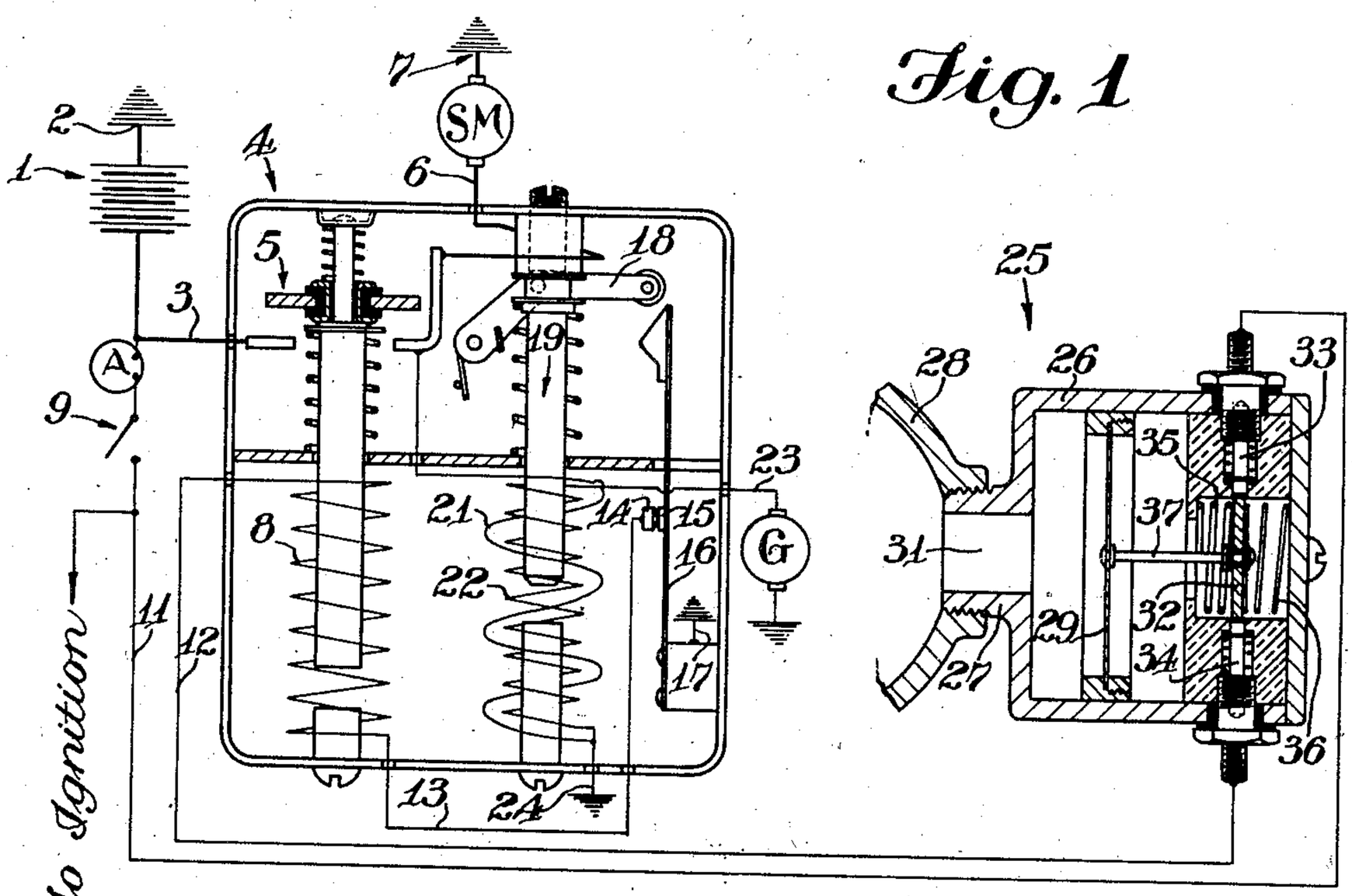
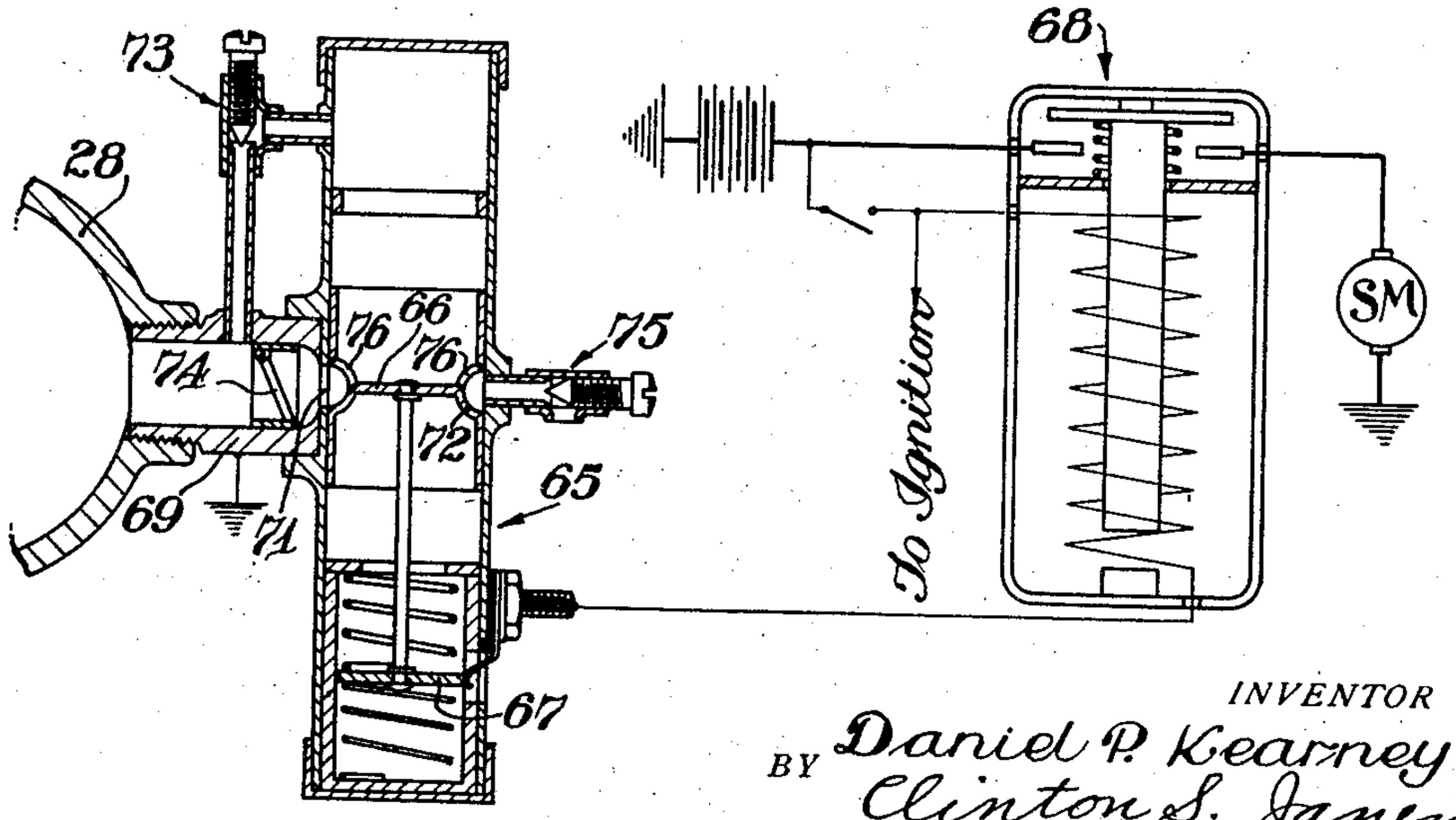


Fig. 5



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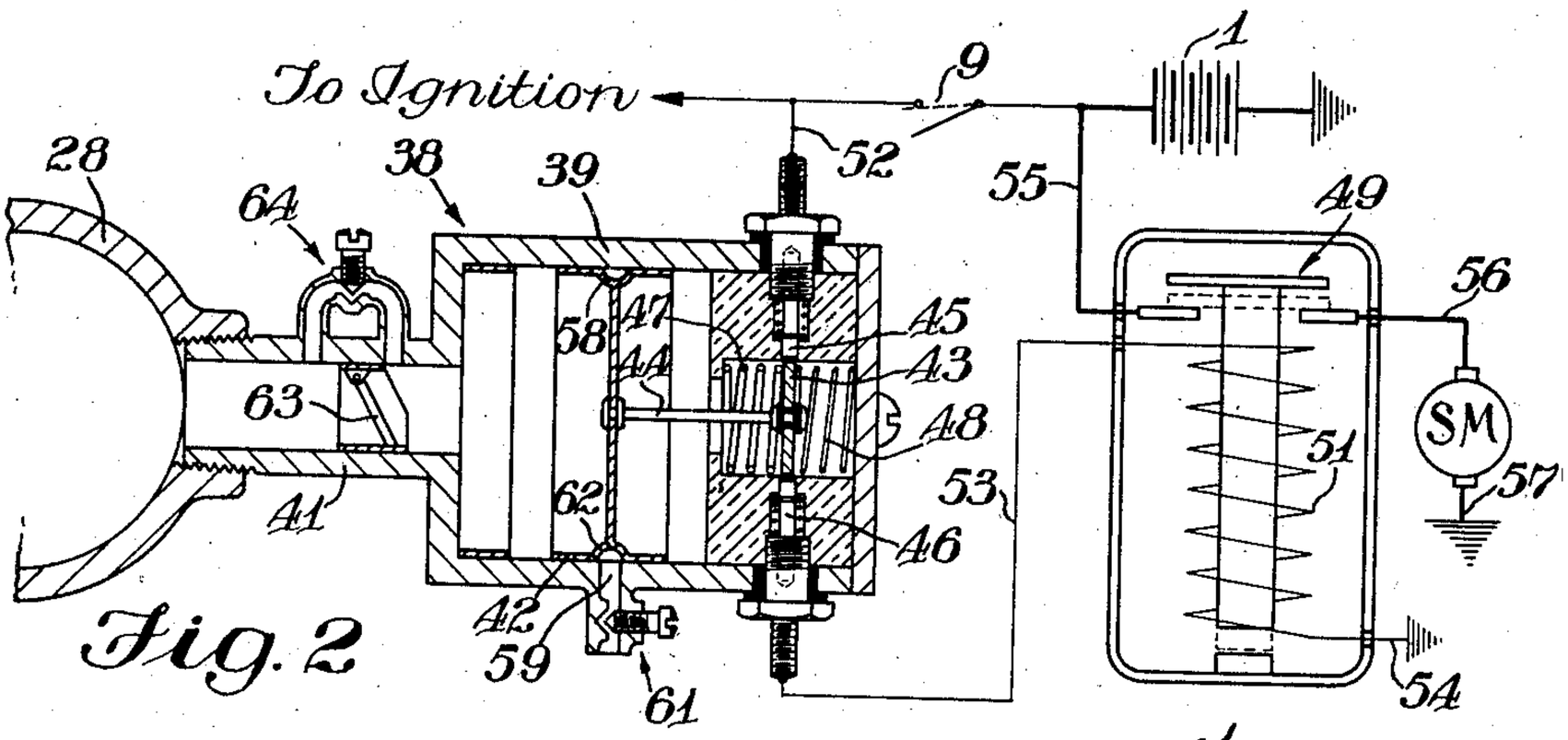

Fig. 2

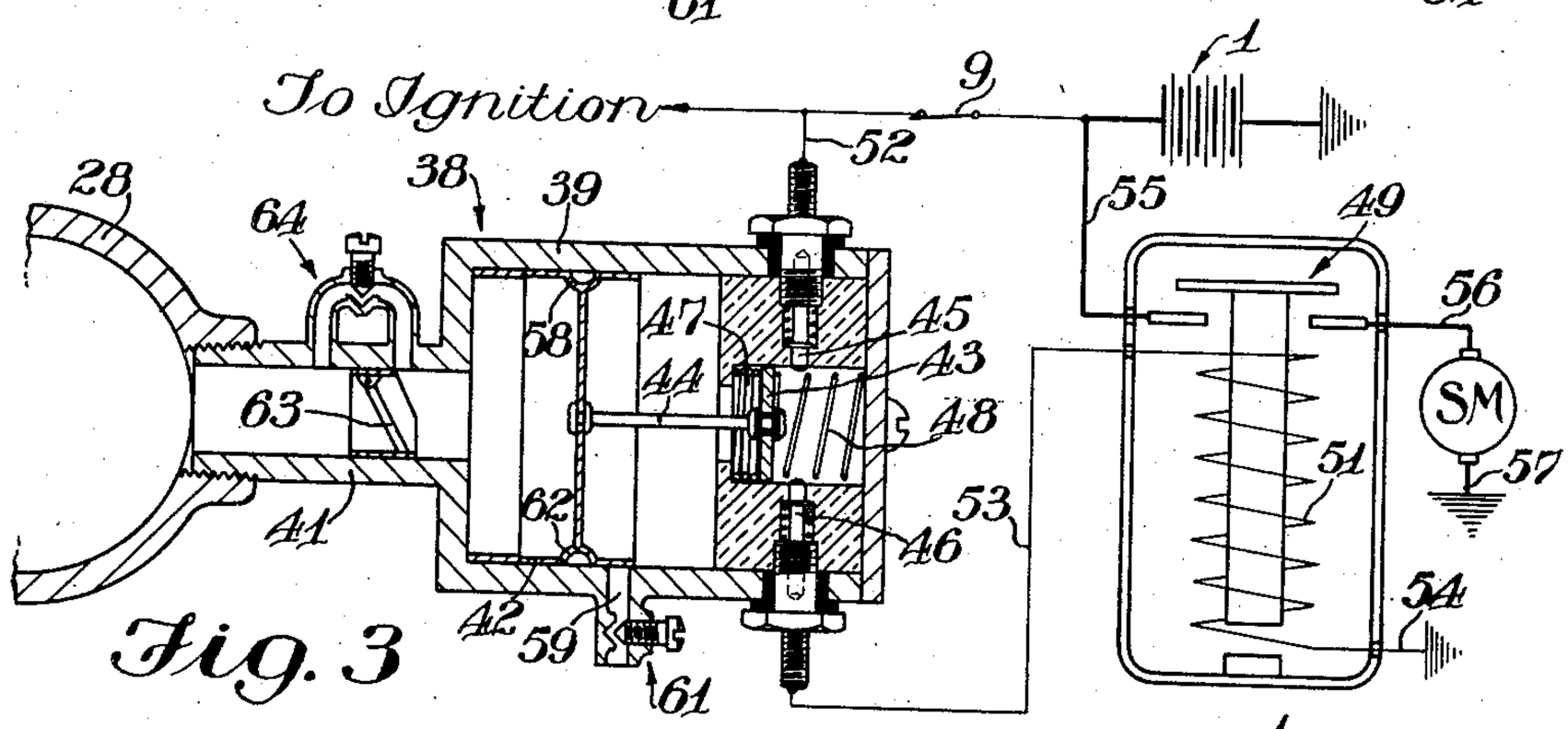

Fig. 3

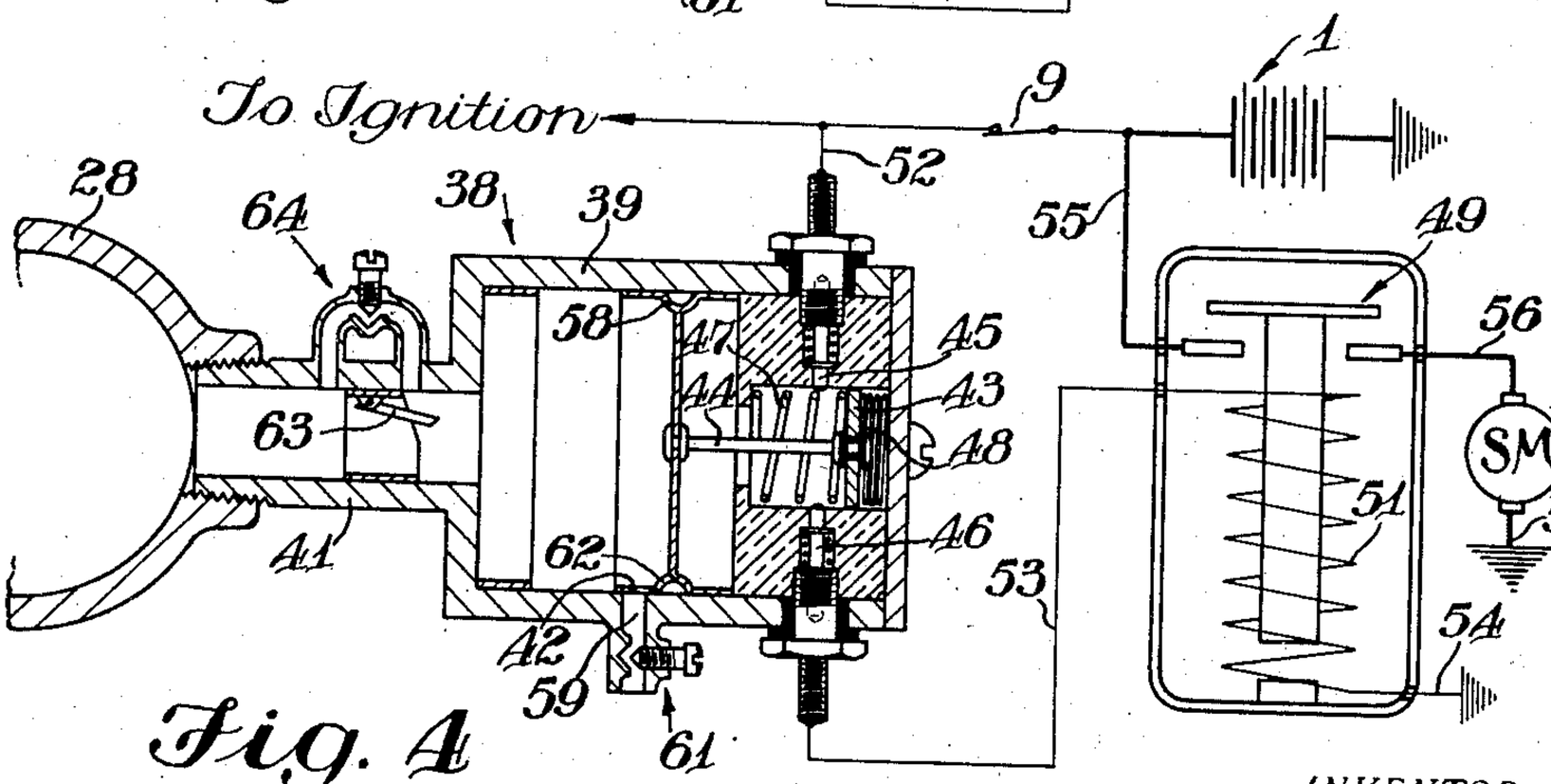

Fig. 4

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AUTOMATIC STARTING MECHANISM

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8 Claims. (Cl. 290—38)

This invention relates to automatic starting mechanism for internal combustion engines and more particularly to controlling means therefor.

Automatic starting mechanisms for internal combustion engines which depend entirely on the current from an engine-driven generator to prevent undesired actuation of the starting mechanism are in general satisfactory due to the reliability of generators as now constructed and due further to the fact that it is readily possible to construct a mechanism so that an extremely feeble generator current will hold out the starting mechanism in the proper manner. It may happen in some installations, however, that the generator becomes entirely inoperative and allows the starting mechanism to be actuated while the engine is in operation; moreover, the generator is usually ineffective to prevent actuation of the starting mechanism when the engine is rotating backward as in case of back-fire.

It is an object of the present invention, therefore, to provide a novel device in connection with automatic starting mechanism which prevents actuation of the starting mechanism when the engine is rotating either forward or backward.

It is another object of the invention to provide such a device which may be used independently of the engine generator or in conjunction therewith.

It is a further object to provide such a device which is reliable and efficient, economical to manufacture, and which may be readily installed and used in conjunction with commercial types of automatic starting mechanism.

Further objects and advantages will be apparent to those skilled in this art from the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a semi-diagrammatic illustration of one preferred form of the invention shown in connection with a commercial form of automatic starting mechanism;

Fig. 2 is a similar illustration of a second embodiment of the invention as used in connection with an ordinary starter switch relay construction, showing in full lines the parts in normal inoperative position and showing in dotted lines the positions assumed during the starting operation;

Fig. 3 is a view similar to Fig. 2, showing the parts in the positions assumed under running conditions;

Fig. 4 is a similar view showing the positions of the parts during back-firing of the engine; and

Fig. 5 is a similar view of a third embodiment of the invention showing the parts in normal inoperative positions.

Referring first to Fig. 1 of the drawings, there is illustrated an electrical starting system for a conventional four-cycle internal combustion engine, not shown, comprising a battery 1, grounded at 2 and connected by means of a lead 3 to an automatic starting mechanism indicated generally at 4. The automatic starting mechanism includes a starting switch 5 which is arranged to connect the lead 3 to a lead 6 which is attached to the starting motor SM, the opposite terminal of which is grounded as at 7, thus completing the starting circuit.

The starting switch 5 is arranged to be operated by a solenoid 8 which is energized by a control circuit from the battery 1 through an ignition switch 9, leads 11 and 12, lead 13, fixed contact 14, movable contact 15 and spring strip 16 which is grounded at 17. Closure of the control circuit thus causes the starting switch 5 to actuate the starting motor and cause the engine to be cranked.

The control circuit is arranged to be opened by a lever 18 which bends back the spring strip 16 to open contacts 14, 15 when a solenoid plunger 19 is actuated by a coil 21. The plunger 19 is retained in its retracted position during normal operation of the engine by a coil 22 which is energized from the generator G by a lead 23, the opposite end of said coil being grounded at 24.

According to the present invention, means are provided for preventing operation of the starting mechanism when the engine is rotating either forward or backward, this means taking the form of a controlling device indicated generally by numeral 25 and comprising a cylindrical chamber 26 having an extension 27 threaded into an element of the engine intake system such as the intake manifold 28. A diaphragm or piston member 29 is mounted for reciprocation in the chamber 26 under the action of pressure or vacuum transmitted from the intake manifold 28 through a passage 31 in the extension 27. The diaphragm 29 is arranged to operate a switch member in such manner that when the diaphragm is subjected to either pressure or vacuum from the intake manifold the switch member will be moved to open position, but will resume its closed position as soon as the pressure or vacuum is released. As here shown, this switch member is in the form of an insulated conducting member 32 adapted to bridge a pair of spring-pressed contacts 33 and 34 when in normal position as defined by springs 35 and 36 located on opposite sides thereof. The switch member 32 is connected to the diaphragm 29 by a suitable rigid coupling member such as indicated at 37 whereby motion of the diaphragm in either direction causes the member 32 to disengage from the contacts 33 and 34.

Contacts 33 and 34 are connected respectively to the leads 11 and 12 of the control circuit whereby the control circuit is completed through the control device 25 when the switch member 32 is in normal position.

In the operation of this device, starting with the parts in the positions shown in Fig. 1, closure

of the ignition switch 9 completes the control circuit whereby the starting switch 5 is closed and the engine is cranked by the starting motor SM. When the engine starts, a vacuum is created in the intake manifold 28 which is transmitted by the passage 31 to the chamber 26 and causes the diaphragm 29 to move the switch member 32 to the left, disengaging the contacts 33 and 34 and thus opening the control circuit and maintaining said circuit open as long as the engine is in operation. Should the engine backfire, a pressure is immediately created in the intake manifold 28 which causes actuation of the diaphragm 29 to the right, thus causing the switch member 32 to disengage contacts 33 and 34 and maintain the control circuit open as long as rearward rotation of the engine persists. As soon as rotation of the engine ceases, the springs 35 or 36 return the switch member 32 to its normal position, thus again completing the control circuit and causing the engine to be cranked.

In as much as it is desirable to maintain proper contact between the switch member 32 and the contacts 33 and 34 during cranking, the spring 35 is arranged as illustrated to be sufficiently stiff to prevent the vacuum caused in the intake manifold due to the cranking operation from moving the switch member 32. This vacuum during cranking is of course less than that during running since the throttle is partially open during cranking and the rotation is slower than normal idling speed. Since it is desirable that the switch member 32 be moved readily in case of back-fire, to its open position, the spring 36 is only made sufficiently strong to return the switch member 32 to its closed position when the intake pressure has been dissipated.

It will be understood that the operation of the controlling device 25 in this embodiment of the invention is supplemental to the various controlling features of the automatic starting mechanism 4 which operate in their usual manner to control the starting mechanism in conjunction with the controlling device 25.

In Figs. 2, 3 and 4 of the drawings there is illustrated a second embodiment of the invention in which provision is made for a somewhat more positive control of the starting mechanism by the intake vacuum and pressure, and an added provision is included for introducing a time delay after the dissipation of the pressure in the intake manifold before the reactuation of the starting mechanism, in order to insure that the engine comes completely to rest after a back-fire before recranking thereof can take place. As here shown, the control mechanism indicated generally at 38 comprises a cylindrical chamber 39 having an extension 41 threaded in a member of the intake system of the engine such as the intake manifold 28.

A piston member 42 is slidably mounted in the chamber 39 and actuates a controlling switch member 43 by means of a rigid connnection 44. Switch member 43 is arranged to bridge contacts 45 and 46 when in normal position as maintained by springs 47 and 48.

In this embodiment of the invention the controlling device 38 is arranged to actuate a starting switch 49 by means of a solenoid 51. For this purpose the controlling device 38 is included in a control circuit from battery 1 through ignition switch 9, lead 52 connected to contact 45 and lead 53 connected to contact 46 and solenoid 51, the latter being grounded at 54. Energization of solenoid 51 causes closure of starting switch 49 which completes the starting circuit from battery 1 through leads 55 and 56 to the starting motor SM which is grounded at 57.

Piston 42 is provided with a circumferential groove 58 which normally registers with a port 59 having an adjustable bleeder opening as indicated at 61. The piston is further provided with an opening 62 from the groove 58 into the interior of the chamber 39 on the side of the piston toward the intake manifold 28.

A check valve 63 is placed in the extension 41 and arranged to allow gas under pressure from the intake manifold to pass freely to the chamber 39 but to prevent escape of such gas from said chamber. An adjustable by-pass 64 is provided for allowing the escape of gas from the chamber 39 into the intake manifold 28.

In the operation of this form of the invention, starting with the parts as shown in Fig. 2, closure of the ignition switch 9 causes energization of solenoid 51 to close the starting switch 49 and causes cranking to take place. During cranking, check valve 63 is closed, and the intake vacuum is effective only through the by-pass 64. The bleeder opening 61 is so adjusted that air can enter the chamber 39 with sufficient freedom to prevent the creation of a vacuum in said chamber great enough to actuate the switch member 43. When the engine starts, the intake vacuum is increased whereby a vacuum is created in the chamber 39 sufficient to move the piston to the left and break the control circuit. At this time, the skirt of the piston 42 moves to close the port 59 as shown in Fig. 3 of the drawings, whereby the bleeder opening 61 is closed and a very slight vacuum from the intake manifold is sufficient to retain the piston in such position, whereby the control circuit is held open as long as there is an appreciable vacuum in the intake manifold.

When the engine back-fires, the pressure created in the intake manifold is admitted instantly to the chamber 39 through check valve 63 as shown in Fig. 4 of the drawings, thus opening the controlling circuit and closing the port 59 by means of the skirt of the piston. When an equilibrium has been established between the chamber 39 and the intake manifold 28, check valve 63 closes, and when the back-firing ceases, the pressure in the chamber 39 is trapped therein and compelled to escape through the adjustable by-pass 64. This by-pass is so adjusted as to establish a suitable time delay before allowing the piston 42 to return to its normal position whereby the engine is allowed to come completely to rest before reactuation of the starting mechanism.

In Fig. 5 there is illustrated a third embodiment of the invention which provides for a time delay before reactuation of the starting mechanism after either forward or rearward rotation of the engine. As there shown, a control device 65 is provided with a slidable piston 66 arranged to actuate a switch member 67 forming the ground connection of a control circuit for the starting relay 68.

The control device 65 is connected to the intake manifold 28 by an inlet 69 opening through a port 71 normally registering with a groove 72 of the piston, and by an adjustable by-pass 73. The inlet 69 is provided with a check valve 74 opening toward the control device. An adjustable bleeder opening 75 is provided also in registry with the normal position of the groove 72 of the piston, and ports 76 are provided for connecting

said groove with the interior of the controlling device.

The operation of this embodiment of the invention is similar to that illustrated in Figs. 2, 3 and 4 of the drawings except that since the inlet 69 of the control device opens through the port 71, the intake will be cut off by the skirt of the piston when the piston is moved from its normal position in either direction. Thus, when the piston has been moved either by vacuum caused by normal running of the engine or by pressure caused by back-firing thereof, the only connection between the controlling device and the intake manifold is through the adjustable by-pass 73. It is obvious therefore that the return of the piston to its normal position is delayed for the length of time necessary for the pressure or vacuum in the controlling device to escape through said by-pass, thus allowing the engine to come to rest before the reactuation of the starting mechanism.

Although certain embodiments of the invention have been shown and described in detail, it will be understood that various other embodiments are possible and changes may be made in the construction and arrangements of the parts thereof without departing from the spirit of the invention as defined in the claims appended hereto.

I claim:

1. Automatic starting mechanism for internal combustion engines comprising in combination with a fuel intake system a starting switch relay and a control switch therefor, means normally holding said control switch closed, and means connected to the intake system of the engine for opening said switch responsive to any substantial deviation from atmospheric pressure in said intake system, said holding means being arranged to resist the opening effect of the intake vacuum on said switch more strongly than it resists the opening effect of intake pressure thereon.

2. Automatic starting mechanism for internal combustion engines comprising in combination with a fuel intake system a starting switch relay, a control switch therefor, means for opening said control switch in response to variations in pressure, and means for transmitting to said pressure responsive means the variations in pressure in the intake system of said engine, said transmitting means offering a free passage for gas toward the pressure responsive means but having a comparatively restricted passage for withdrawing gas therefrom.

3. Automatic starting mechanism for internal combustion engines comprising in combination with a fuel intake system a starting switch relay, a control switch therefor, means for opening said control switch in response to variations in pressure, and means for transmitting to said pressure responsive means the variations in pressure in the intake system of said engine, said transmitting means offering a free passage for gas toward the pressure responsive means but having a comparatively restricted passage for withdrawing gas therefrom, said pressure responsive means having a bleeder passage normally opened to the atmosphere.

4. Automatic starting mechanism for internal combustion engines comprising in combination with a fuel intake system a starting switch relay, a control switch therefor, means for opening said control switch in response to variations in pressure, and means for transmitting to said pressure responsive means the variations in pressure in the intake system of said engine, said transmitting means offering a free passage for gas toward the pressure responsive means but having a comparatively restricted passage for withdrawing gas therefrom, said pressure responsive means having a bleeder passage normally opened to the atmosphere, and means for closing said bleeder opening when the pressure responsive means is operated to open the control switch.

5. Automatic starting mechanism for internal combustion engines comprising in combination with a fuel intake system a starting switch relay, a control switch therefor, means for opening said control switch in response to variations in pressure, said pressure responsive means including a storage chamber, and means for transmitting variations in pressure in the intake system of the engine to said pressure responsive means, said transmitting means allowing free passage of gases to the pressure responsive means when the control switch is closed but providing a restricted passage when the control switch is open.

6. Automatic starting mechanism for internal combustion engines comprising in combination with a fuel intake system a starting switch relay, a control switch therefor, means for opening said control switch in response to variations in pressure, said pressure responsive means including a storage chamber, and means for transmitting variations in pressure in the intake system of the engine to said pressure responsive means, said transmitting means having a restricted passage for withdrawing gases from the pressure responsive means and allowing free passage of gases to the pressure responsive means when the control switch is closed, said free passage being closed when the control switch is open.

7. Automatic starting mechanism for internal combustion engines comprising in combination with a fuel intake system a starting switch relay, a control switch therefor, means for opening said control switch in response to variations in pressure, said pressure responsive means including a storage chamber, and means for transmitting variations in pressure in the intake system of the engine to said pressure responsive means, said transmitting means having a restricted passage for withdrawing gases from the pressure responsive means and allowing free passage of gases to the pressure responsive means when the control switch is closed, said free passage being closed when the control switch is open, said pressure responsive means being provided with a bleeder passage which is open when the control switch is closed and is closed when the control switch is open.

8. An automatic controller for internal combustion engine starters comprising with an internal combustion engine, an ignition circuit therefor comprising a switch, a starting motor, means including a switch having an actuating coil in circuit with the first switch for controlling the operation of the motor, means actuated by the existence of pressure either above or below atmosphere in the intake manifold for maintaining the coil circuit open.

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